β 163.

1876.09	252°.3	1″.15	7.1 — 9.0	4^n	DEMBOWSKI.
1891.52	254 .6	0 .75	7.2 — 9.8	3	BURNHAM.
1895.46	251 .9	0 .56	....	5	SCHIAPARELLI.

It will be noted that the four systems are similar in point of the relative magnitudes of their components, and, in a general way, in point of their angular separation (excluding the early measures of Σ 554 and of β 163). If we had to deal with only one star, or one observer, or one telescope, it would not be difficult to suggest plausible explanations for the negative results. As it is, it seems hardly credible that the failures to see the fainter stars can be due to poor seeing. In my own case my records show that other close and unequal pairs, including some exceedingly difficult ones, were measured on the nights when negative results were obtained for the four named. Nor does it seem at all possible, except perhaps in the case of β 163, that the angular separation of these pairs was too small to permit the companion to be seen on so many different dates. The positive measures seem to exclude this explanation.

Of course, we may fall back upon the hypothesis of variability in the light of the companion-star; but one hesitates to advance that explanation in the absence of any positive observations of variability. There seems to be no reason in the nature of things why the component of a binary system should not be variable as well as any single star, but it has too often proved in the past that the suspected variability of a double star has been due simply to poor seeing or to a poor telescope. For the present, therefore, the problem remains, and adds to the interest of these systems.

R. G. AITKEN.

January, 1906.

SOME TESTS OF THE SNOW TELESCOPE.[1]

In the preliminary tests of the Snow telescope at the Yerkes Observatory, the results were rather disappointing, though good images were occasionally obtained. It was evident that difficulty might be expected from the distortion of the mirrors

[1] Abstract of *Contributions from the Solar Observatory*, No. 4.

by the Sun's heat, and in the first experiments on Mt. Wilson this expectation was realized. Soon after the exposure of the mirrors to the Sun it was seen that the focal length was increasing, and, as the focus changed, evidence of the astigmatism of the mirrors made itself apparent in the appearance of the image inside and outside the focal plane. Since the change of focus amounted in some cases to as much as twelve inches (30.4^{cm}), and since the astigmatism under such circumstances was very marked, it was feared that great difficulty would be experienced in the use of the telescope, particularly as the focus at the opposite limbs of the Sun on one occasion differed by as much as three inches (7.6^{cm}). The change of focal length at different times did not seem to be the same, even for equal altitudes of the Sun. This was soon traced to the change in the amount of heat absorbed by the mirror as the silver film deteriorated in use. Another variable, as subsequent experiments proved, was introduced by the strength of the wind and the temperature of the air blown across the mirror surface. On a day with a cool breeze the focus changed less than on a day with no wind. Naturally enough, the height of the Sun above the horizon proved to be a very important factor, so that the focus changed much more rapidly near noon than early in the morning.

From the outset, the advantages of observing the Sun during the early morning hours had been apparent. In view of the difficulties that were being experienced, this point was again carefully investigated, and it was soon found that with the Snow telescope the finest definition is to be expected about one hour after sunrise. At this time the mountain is but little heated, and the atmospheric absorption reduces the intensity of the solar radiation to such a degree that the mirrors change their figure slowly. If the mirrors are shielded from sunlight between exposures of photographs, and if the exposure time is made as short as possible, excellent results can be obtained during a period of about an hour in the early morning, and usually during a similar period not long before sunset.

It must be understood that the precautions mentioned are necessary only when it is desired to secure the finest possible definition of the solar image. When such precautions are used, the average photographs taken during the summer in the early

morning with the Snow telescope and temporary spectroheliograph are but little inferior to the best photographs, secured on only a few days in the year, with the 40-inch Yerkes telescope and the Rumford spectroheliograph. The best photographs taken on Mt. Wilson are distinctly superior to the best ever secured by Mr. ELLERMAN and myself with the 40-inch telescope. Unless these points were made clear, it might be supposed that no work could be done with the Snow telescope except under the conditions stated. As a matter of fact, however, very fair photographs can be obtained with the spectroheliograph at almost any time during a cool day, and in the early morning and late afternoon hours of a hot day without wind. It is only necessary to arrange the daily programme of observations so that the spectroheliograph, which requires the finest definition, is used during the period when the seeing is best. Photographic work on the spectra of sun-spots follows, and after this is completed the conditions are entirely satisfactory for various other observations, such as bolographic work on the absorption of the solar atmosphere, etc.

The ventilated house provided for the Snow telescope has proved so satisfactory that it has not seemed necessary to make further experiments on the use of Langley's method of stirring the air along the path of the beam. It is usually found best to lower the inner canvas wall on the side of the house away from the Sun, leaving the canvas wall on the opposite side of the house in place, so that the heated air under the louvers may pass upward and out through the ventilated roof, instead of entering the house and disturbing the beam.

While fans have not been employed for stirring the air, they have nevertheless been used to advantage in blowing the mirrors, for the purpose of preventing a rapid change of figure. In the first experiments, a fan four feet in diameter, driven by an electric motor, was mounted at the south end of the cœlostat pier. Air from this fan was led to the cœlostat mirror and the second mirror through large canvas tubes. In these experiments the concave mirror did not receive a blast of air, as it was thought the effect could be detected sufficiently well if only the first and second mirrors were cooled in this way. As it was found that the focus could be varied through a considerable range by blowing the first two mirrors, arrange-

ments have been made to cool all the mirrors in the same way. The small electric fans to be used for this purpose will be operated while the adjustments of the spectroheliograph are being made, and also between exposures, when the mirrors are shielded from the Sun by an adjustable canvas screen.

Excellent definition is obtained at night with the Snow telescope, except when the mirrors have been exposed to the Sun for some hours during the afternoon. On such occasions the rapid change of figure during the early evening results in irregular distortions, as indicated by the multiple images sometimes observed. Without such previous exposure to the Sun, the images of the stars and of the Moon leave nothing to be desired. Nevertheless there is a considerable change of focal length during the night, but this would be inappreciable during short exposures, and during long exposures on stellar spectra it is only necessary to correct the focus by changing the position of the concave mirror from time to time.

From a mechanical standpoint the Snow telescope has proved to be completely successful. From an optical standpoint it has shown itself capable of giving results with the spectroheliograph superior to those obtained in our work with the 40-inch refractor. In view of the advantages it offers for many classes of astrophysical research, this telescope may now be considered to have passed the experimental stage, though the possibility of providing better material for the mirrors indicates that its optical performance will probably be considerably improved in the future.

GEORGE E. HALE.

SOLAR OBSERVATORY.

PHOTOGRAPHIC OBSERVATIONS OF THE SPECTRA OF SUN-SPOTS.[1]

(1) Our photographs of the spectra of sun-spots clearly record the strengthened and weakened lines, and can be advantageously used in place of visual observations.

(2) Table I gives the intensities on the photographs of the principal lines in the region λ 5000 – λ 5850.

(3) Table II shows that nearly three quarters of these lines are identified in ROWLAND's table, and thus fails to support

[1] Summary of results given in *Contributions from the Solar Observatory*, No. 5.